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May 18, 2016

Mr. Dave Navecky
Surface Transportation Board
Docket No. FD 35952
395 E Street SW
Washington, DC 20423-0001

Mr. Navecky,

This letter addresses Purdue University Northwest (PNW)'s concerns about the proposed Great Lakes Basin Transportation, Inc. (GLBT) rail line in the immediate vicinity of PNW's Northwest Indiana Robotic (NIRo) observatory.

If the rail line is built as proposed, the only practical remedy is to relocate the entire facility to another site. Relocating the observatory will require significant time to find a new location and would incur expenses equivalent to the original costs. It would also effectively halt any research activity for at least one academic year. If this rail line is built as proposed, PNW requests that GLBT, Inc. set aside $250k for costs associated with the facility's relocation.

The NIRo observatory is a federally funded project, begun in 2005 and dedicated in 2010. Had a rail line been there when we were scouting locations and discussing options with the CAC and the LCPRD in 2006, our current site would have been deemed unacceptable for construction of a research-grade optical astronomy observatory. Over the past decade, approximately $275,000 has been invested in the NIRo observatory ($150k from the National Science Foundation, $108k from PNW and an additional $17k from private fundraising). If the proposed rail line goes through, the NIRo observatory will become unusable for its intended purpose.

The NIRo observatory is situated at the Calumet Astronomy Center (CAC) in Lowell, IN. The CAC is a joint venture of PNW, the Calumet Astronomical Society (CAS), and the Lake County Parks and Recreation Dept. (LCPRD). It is the permanent home of both PNW's NIRo telescope and the CAS's Thomas Conway observatory. Full details about the NIRo telescope, its history, and research accomplishments can be found at http://centers.pnw.edu/astronomy-center/.

According to the Google Earth map provided in the GLBT Rail Line environmental impact statement[1], the proposed rail line passes extremely close to the NIRo observatory. A magnified view near mile 43, courtesy of

[1] http://greatlakesbasinraileis.com/maps.html

Calumet Campus
2200 169th Street ▪ Hammond, IN 46323
(219) 989-2204 ▪ pnw.edu

North Central Campus
1401 S. U.S. Hwy. 421 ▪ Westville, IN 46391
(219) 785-5433 ▪ pnw.edu

Google Earth, shows the CAC site with the NIRo structure highlighted near the intersection of Chase St and 191st St. on the SE side of Lowell, IN.

[Image attached at end of scanned document]

Google Earth measures the closest approach at approximately 235 feet (to the red rail line, not the green right-of-way line) due north of the NIRo structure. Documentation on the GLBT website states the rail line will handle up to 110 trains per day at speeds of up to 70 mph[2]. While it is difficult to give an exact minimum safe distance to avoid any detectable ground vibration at the NIRo telescope, if the rail line were to be shifted to the north side of Lowell, IN or to the south by at least one mile, beginning at the mile-41 marker, to align with the present position of the mile-45 marker, then it is estimated that the ground vibrations and stray light would be sufficiently diminished to allow the NIRo telescope to continue its current operations.

We make this request in light of the following two concerns, specific to research activities at the NIRo observatory, as well as the concerns already voiced by the LCPRD, the CAC, and others.

1. **Vibrational decibels**

Our primary concern is the vibration associated with passing, high-speed freight trains. The Federal Transit Administration's Noise and Vibration Impact Assessment states that a limit for vibration for frequent (>70 per day) events in buildings with 'sensitive instruments' where vibrations would interfere with interior operations is 65 VdB[3].

[2] http://greatlakesbasinraileis.com/index.html
[3] Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, FTA-VA-90-1003-06, May 2006

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Actual vibrations will depend on ground structure, water table, depth of bedrock, etc. but typical values for freight rail traveling at 45 mph are 88 VdB at 50 feet, 82 VdB at 100 feet, and 76 VdB at 200 feet[4]. Even allowing for a substantial variation for differing ground structure and train speeds, we expect values not less than 70 VdB at 240 feet. This is well above the 65-VdB sensitivity limit for delicate instrumentation, such as the NIRo telescope.

The telescope itself sits atop a ~15-foot concrete pier that is vibrationally isolated from the rest of the building. The design of the structure is such that there is no vibration from the building transferred to the telescope. But the isolated concrete pier extends a similar distance into the ground. ~70 Vdb transmitted to the concrete pier, then amplified as it travels up to the telescope will adversely effect the quality of any images taken while a train is passing (as frequently as once every 13 minutes on average). Since the camera used has pixels which are 12 microns in size, once transmitted up 15 feet of concrete pier, a vibration of one part in several hundred thousand will cause blurring in the image plane greater than one pixel.

In addition to the acute problem of being unable to take images while a train is going by, there is also the concern about chronic vibrations as trains pass day and night. With up to 110 trains per day at several minutes per train, the telescope and its instrumentation will be subject to continual vibration for 7-10 hours of the day, every day. This chronic, low-level wear-and-tear will drastically reduce the effective lifetime of the facility.

2. Stray light

As a secondary concern, the light from approaching trains will negatively impact our ability to collect data. We often take images of objects which are 5-6 million times fainter than can be detected with the naked eye and require optical noise levels to be 100 times fainter than the signal itself. Even indirect lighting from train headlights could be detected and adversely affect any image being taken while a train passes by.

This is much harder to model, as it will depend on the exact engine, whether it has one or two bulbs in the headlamp, the shape of the headlamp housing and reflector dish, etc. The amount stray light the telescope collects will also depend on where the telescope happens to be pointing as a train passes. As it will vary greatly from train to train and pointing to pointing, it will be practically impossible to correct for this during data calibration.

The Federal Code of Regulations states that train headlights must have a minimum 200,000 candela and suggest a single PAR-56, 200-watt, 30-V lamp[5]. Using specs from such a bulb from GE (135,000 candela at 9°) with the telescope about 240 feet from the rail line, the headlamp will directly illuminate the observatory until the train is about 1600 feet away. Assuming only 1% of the light is evenly reflected off about 100 square-centimeters of the telescope's superstructure, the primary mirror would still collect about 1.85e-6 lumens from the headlamp. Even if that were spread out over all of the 9.3 million pixels of the camera, that is about 2e-13 lumen for every pixel.

[4] Bottineau Transitway, Vibration Fact Sheet, March 2015
[5] Code of Federal Regulations, Title 49, section 229.125, subsection (a)(1).

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Compare that to a typical asteroid (ex.: asteroid (2650)Elinor during our Feb 2016 observing campaign). Based on its brightness and position, plus typical size and reflectivity estimates, we collect about 3.6e-14 lumens from the asteroid in an image which takes up about 20 pixels on the chip. To accurately and precisely measure the brightness of such an asteroid, noise levels need to be less than about 3.6e-16 lumens per pixel. This rough estimate of stray-light noise from a train's headlamp exceeds the required minimum by a factor of 500 or more.

In closing, PNW feels that the construction of the GLBT rail line less than 250 feet from the NIRO observatory would render the telescope useless for its intended purposes. We strongly recommend that an alternate route be determined as outlined above. Barring that, we request funds sufficient to physically relocate the entire facility to a new, suitable site.

Thank you for your time.

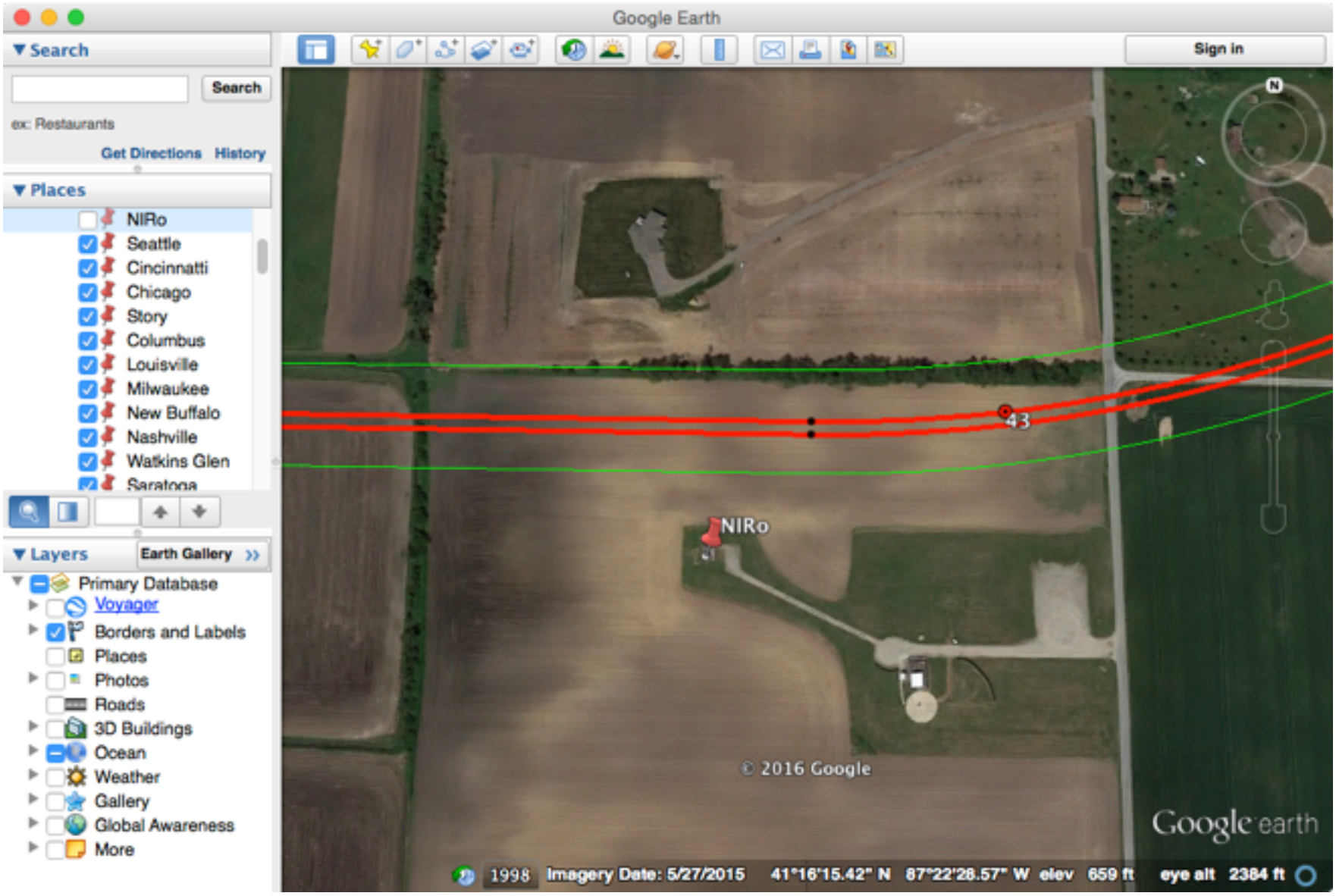
Sincerely,

Adam Rengstorf
Associate Professor of Physics and Astronomy, Department of Chemistry and Physics

Daniel Suson
Interim Department Head, Department of Chemistry and Physics

Kenneth Holford
Dean, College of Engineering and Sciences

Thomas L. Keon
Chancellor, Purdue University Northwest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